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Title: H- Beam Chopper Overview

Author(s): Bradley, Joseph Thomas III

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Los Alamos
NATIONAL LABORATORY
EST.1943

H- Beam Chopper Overview

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Joe Bradley III

Outline

- H-Chopper Pattern Requirements
- H-Chopper Structure
- H-Chopper Modulator
- H-Chopper Performance

H-Chopper Pulse Patterns.

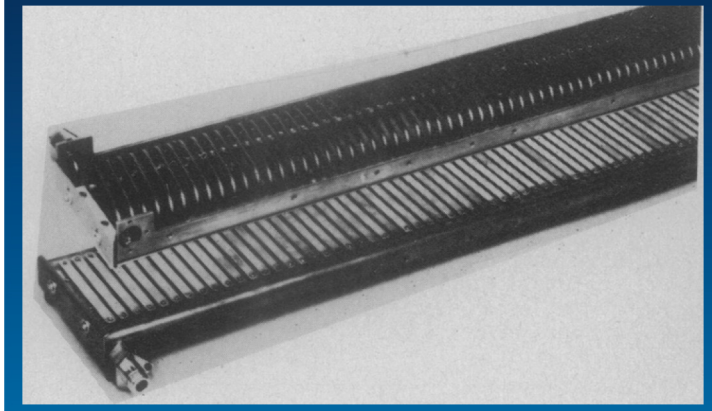
- The two most common patterns the beam chopper must produce are a Proton Storage Ring (PSR) filling pattern and a WNR one micropulse pattern.
- The PSR pattern is used to fill a ring with a 360 ns period.
- Typically the beam passes for 260 ns and then is chopped for 60 ns to allow a gap for beam extraction from the ring.
- This pattern is repeated 2000 times during a macropulse.
- 20 macropulses are sent to PSR per second.

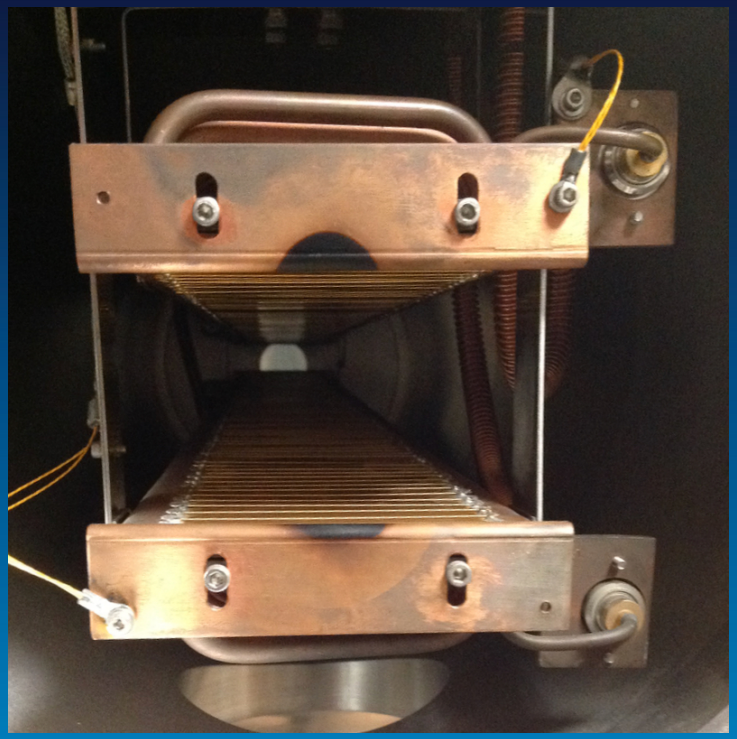
H-Chopper Pulse Patterns.

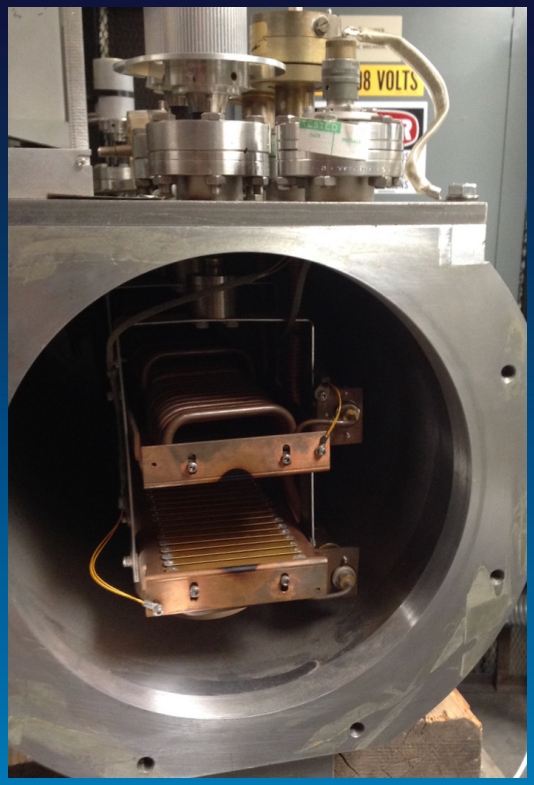
- The WNR pulse pattern requires that a beam pulse at most 25 ns be allowed to pass. A low frequency buncher compresses this pulse into a 5 ns pulse just as it reaches the main buncher.
- The main buncher compresses this 5 ns pulse into a single micropulse. Any current outside the 5 ns window is compressed into adjacent or “satellite” micropulses.
- Current in satellite micropulses degrades the resolution of the WNR experiments.
- Reducing the chopper beam pulsewidth eliminates the satellites at the expense of significantly reduced charge in the micropulse.

- H- Choppers and Bunchers, D. Clark, MP-6, 1991

H-Chopper Structure consists of two arrays of strip line transmission lines connected across the backs by coax lines in vacuum.







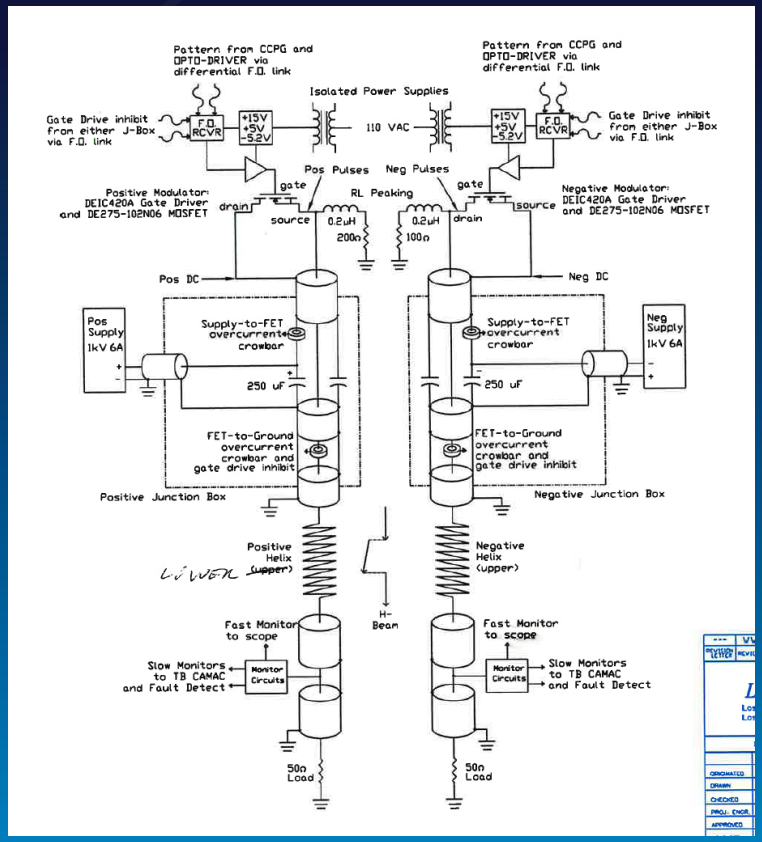
•J. S. Lunsford and R. A. Hardekopf, AT-3, IEEE Transactions on Nuclear Science, Vol. NS-30, No. 4, August 1983.

H-Chopper Structure geometry.

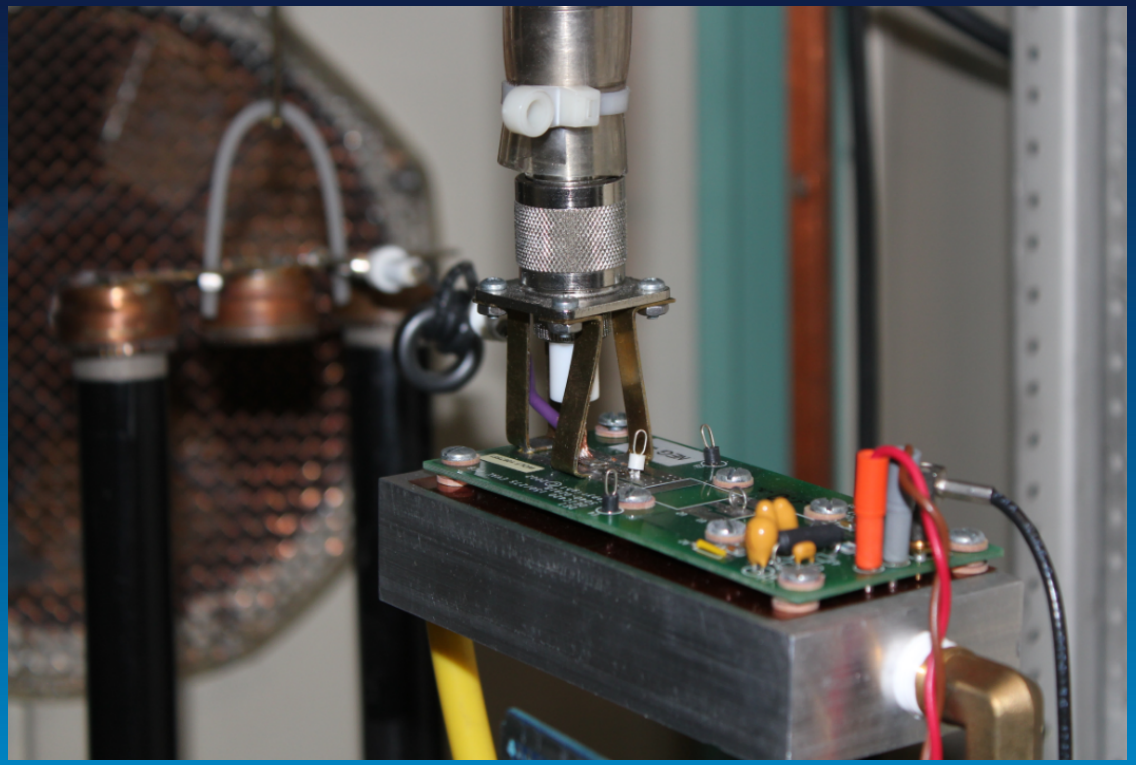
- Each helix is 975 mm long and 76.2 mm wide
- Average spacing between the helices plates is about 27 mm.
- Beam energy at output of Cockroft-Walton 750keV which gives a beam beta of 0.04 and transit time of 81.4 ns.
- Aspect ratio = 0.78

- H- Choppers and Bunchers, D. Clark, MP-6, 1991

H-Chopper Modulators and Loads located downstairs below beamline.



Switching for each helix done by a single FET on an electrically floating, capacitively isolated heat sink.



H-Chopper System FET switch

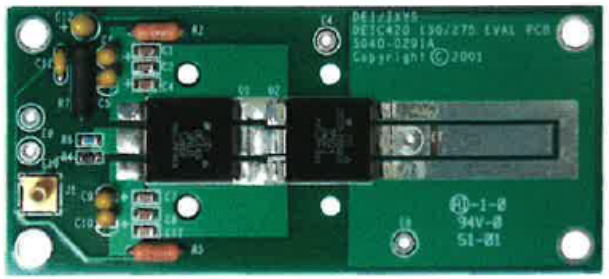
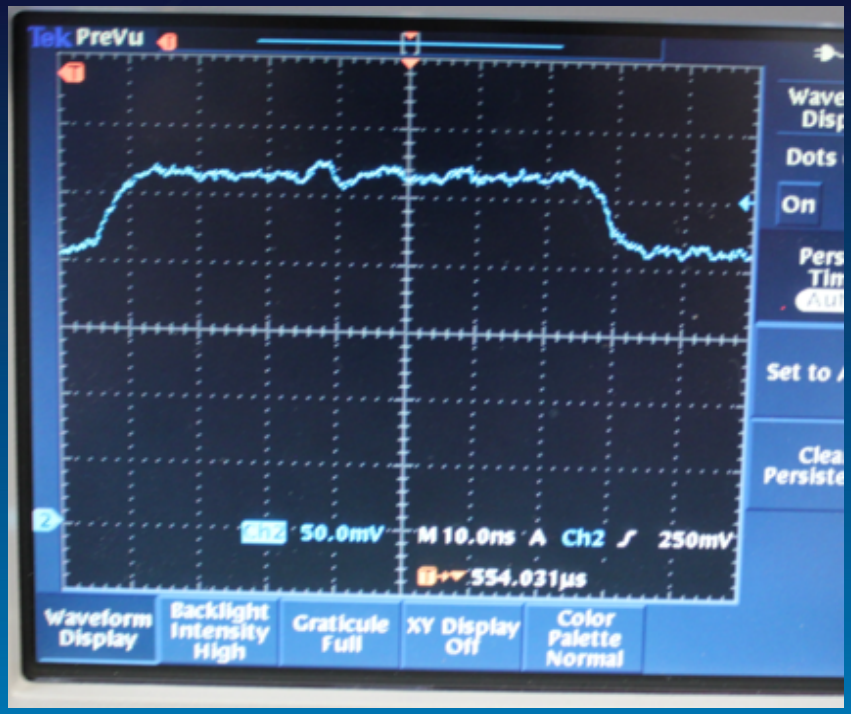


Figure 1 - EVIC420 Evaluation Board
DEI DEIC420 shown in low-power mounting configuration (see Figure 2). DE275-102N06A MOSFET installed in low-power configuration for illustration purposes only

- DE275-102N06A FET driven by a DEIC420 gate drive on the EVIC420 evaluation board.
- Rated for 1000V with a < 5 ns turn on and turn off time.

H-Chopper FET Performance

- ECL logic and complementary FO lines (pos and neg logic) are used to speed up the rise time.

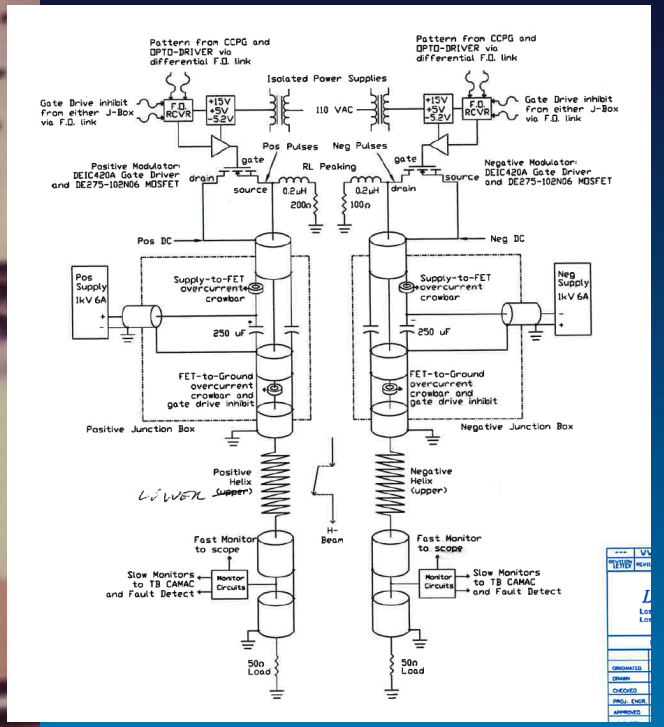


- Fiber optic input to the FO receiver board. Risetime ~6ns

- Drive to the FET board. ~3.2ns.

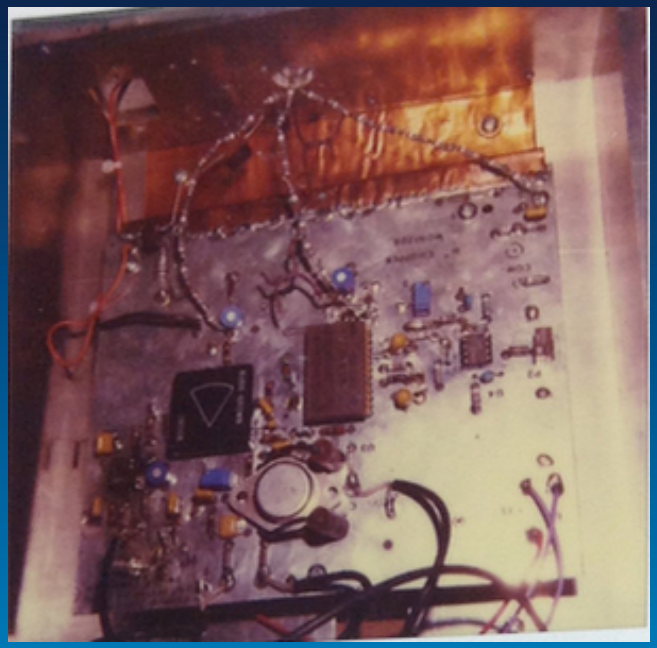
H-Chopper Capacitor Bank

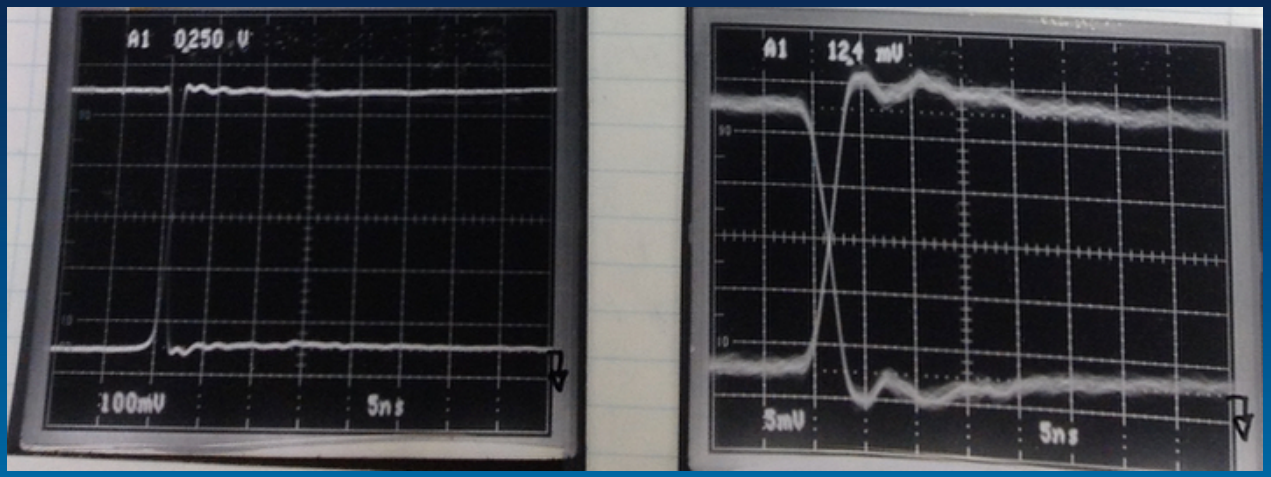
- A 250 μF capacitor bank is connected from the shield of the short cable coming from the FET board to the grounded shield of the Heliax cable leading to the chopper.
- The bank consists of arrays of smaller, low inductance caps in parallel with larger, higher inductance caps to give a relatively flat frequency response over a typical pulse.



H-Chopper Diagnostics

- The original chopper diagnostics included a filtered and amplified load voltage signal.
- When calibrated with a 2 ns rise time pulser, the rise time of this readback was 3-4 ns.





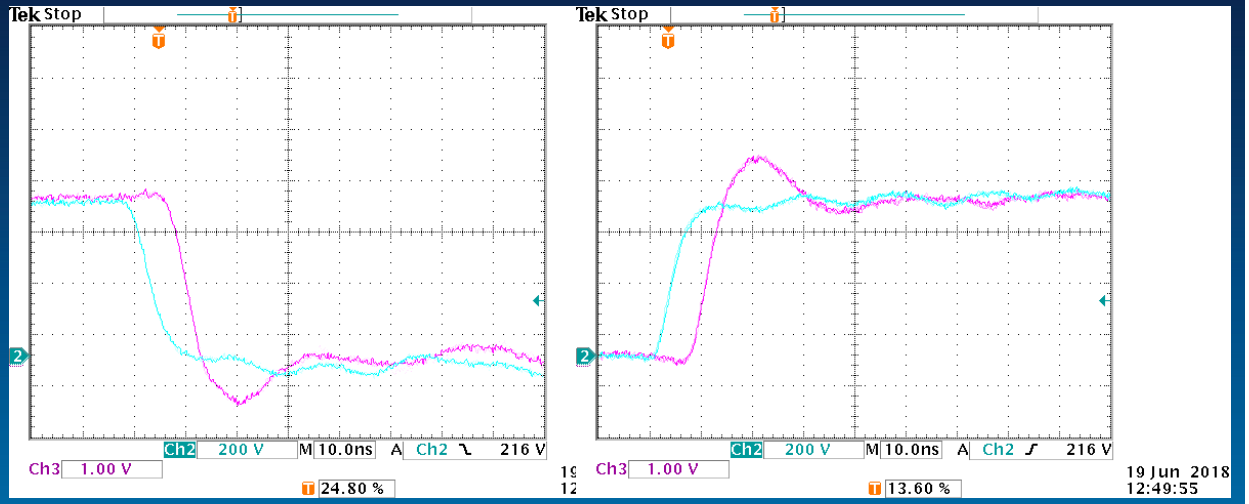
Input

Output

H-Chopper Diagnostics

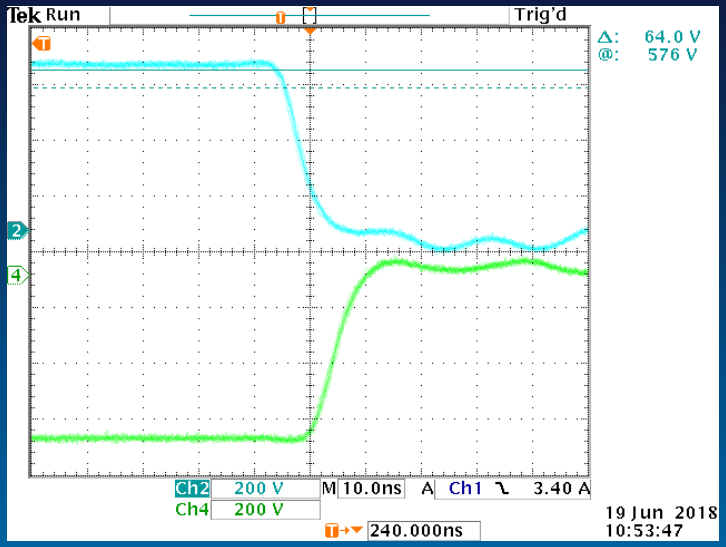
- A recent upgrade was to add a voltage probe (TEK P5100A, 2.5kV, 500MHz, 2.5 pf, /100 probe) tapped into the coax using an hp 8405A accessory kit just before the 50 ohm load.

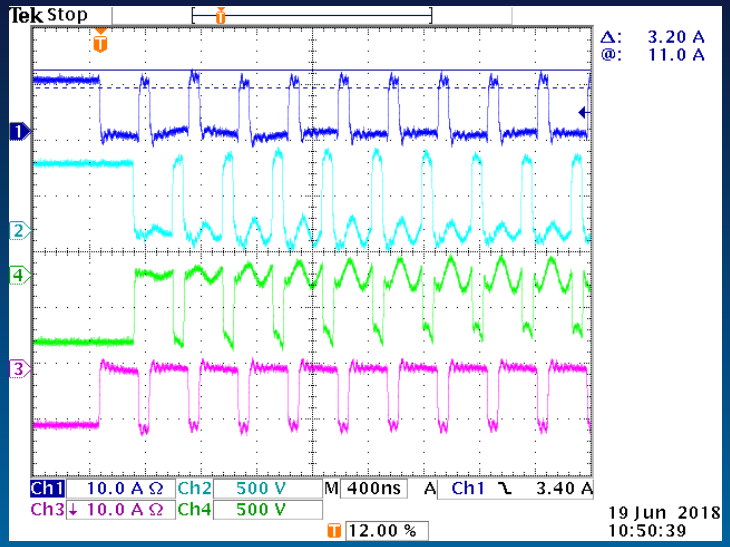
- Original diagnostic in pink.
- TEK probe in blue.
- Test results show a the TEK probe has a similar risetime, but less ringing.
- Rise time is approximately 10 ns.



H-Chopper Performance

- The new voltage probes indicate that the rise time of the pulse coming out of the chopper and entering the load has a fall time of 7 ns.





- Successive pulses show more oscillations, which may indicate reflections from the load.
- However, the current diagnostic in the connection chassis with capacitor bank does not show these oscillations.